Carnegie Mellon
Software Engineering Institute

Capability Maturity Model Integration

CMMI®

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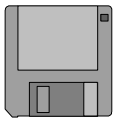
CMMI - Adding Systems Emphasis to Software Intensive Systems

- **Many problems identified in software are related to systems issues**
  - Problems surface too late in the development cycle
  - Complex systems can no longer be segregated into software and hardware
  - Absolute reliance on software for systems integrity demands that systems and software be treated together for process improvement
- **Integrated Systems Engineering from SECM**
- **Emphasized SW Engineering from SW-CMM**

Focus of CMMI

CMMI is applied here



SW-CMM is applied here

A Gaggle of CMMs

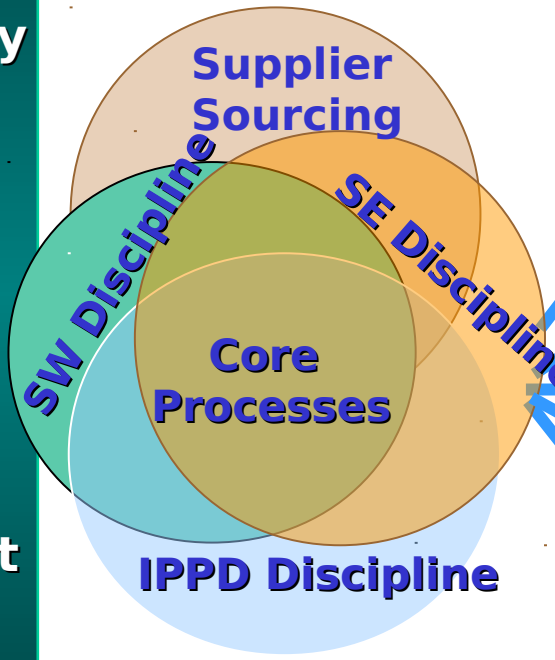
- Most with similar PAs *but each with its own spin*

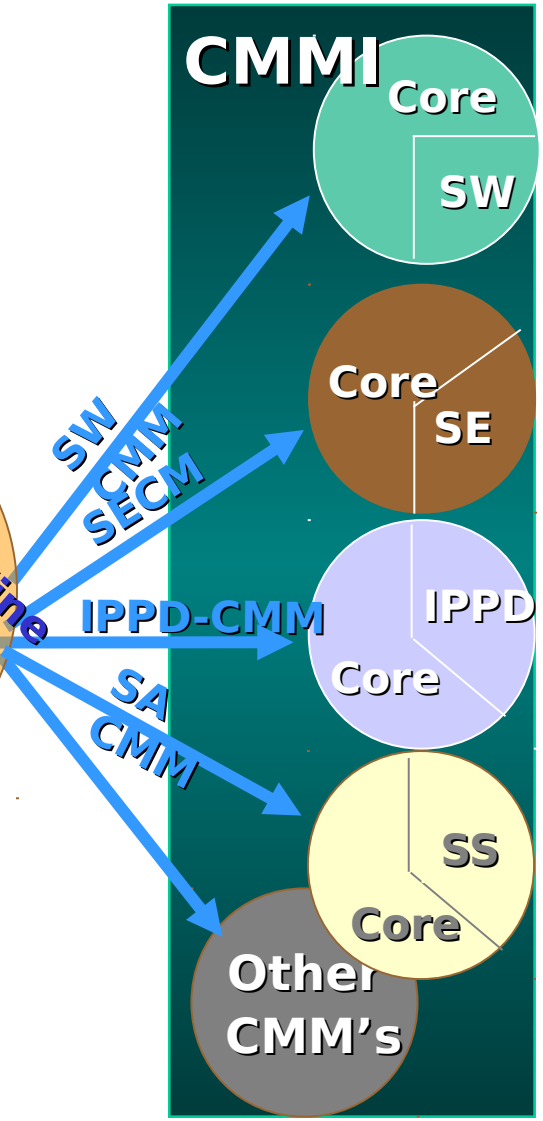
Software CMM	staged	software development
System Engineering CMM	continuous	system engineering
System Engineering Capability Model	continuous	system engineering
Software Acquisition CMM	staged	software acquisition
System Security Engineering CMM	continuous	security engineering
Personal Software Process	staged	individual software development
FAA-CMM	continuous	software engineering, systems engineering, and acquisition
IPD-CMM	continuous	integrated product development
People CMM	staged	workforce
SPICE Model	continuous	software development

Why CMMI:

Multiple Applications:

- IT Consulting
- Sys Arch, Engin & Delivery
- Enterprise Integration
- Data Center Operation
- IT Infrastructure Management
- Applications Management
- SETA
- Functional Process Outsourcing

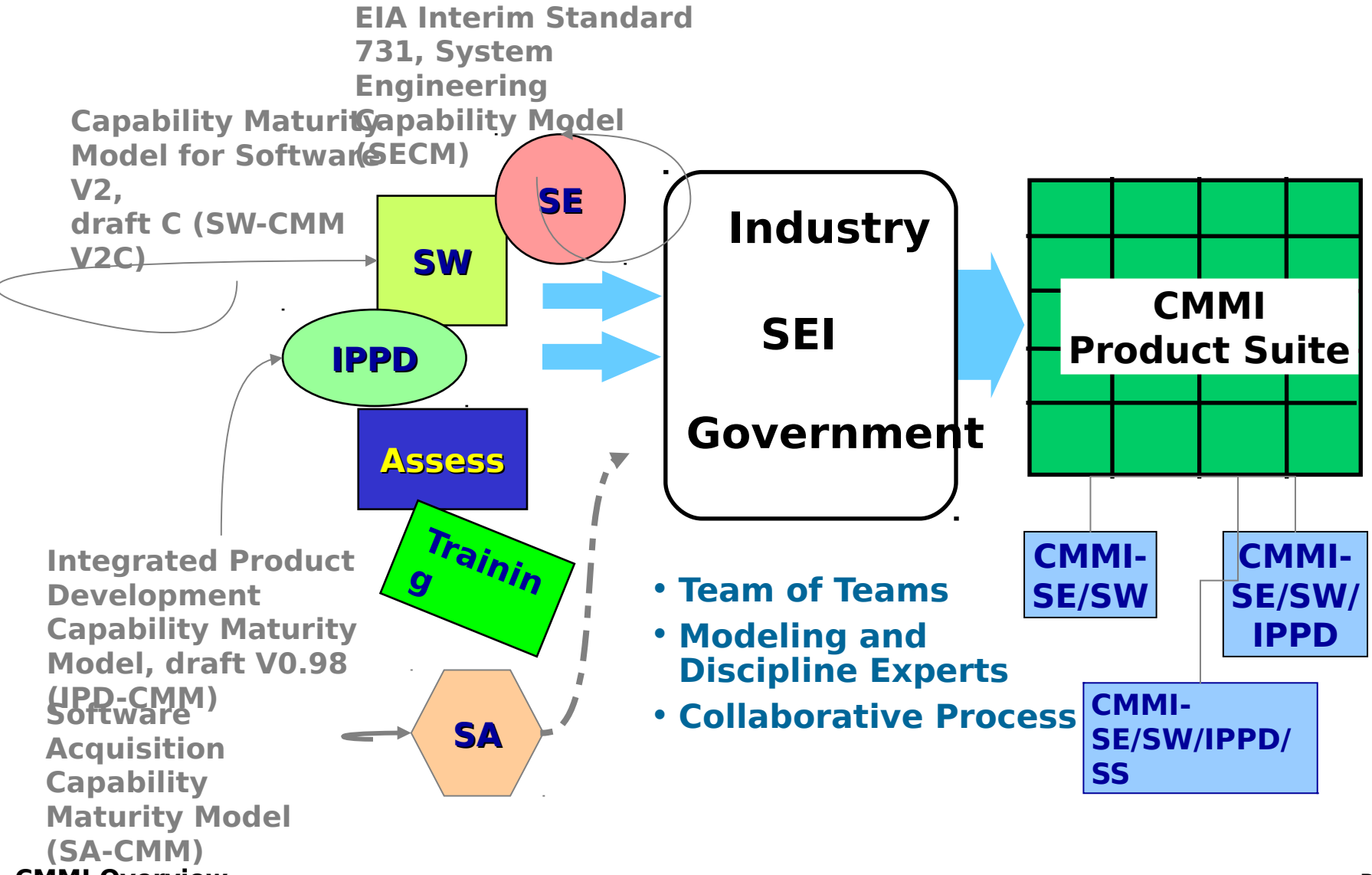




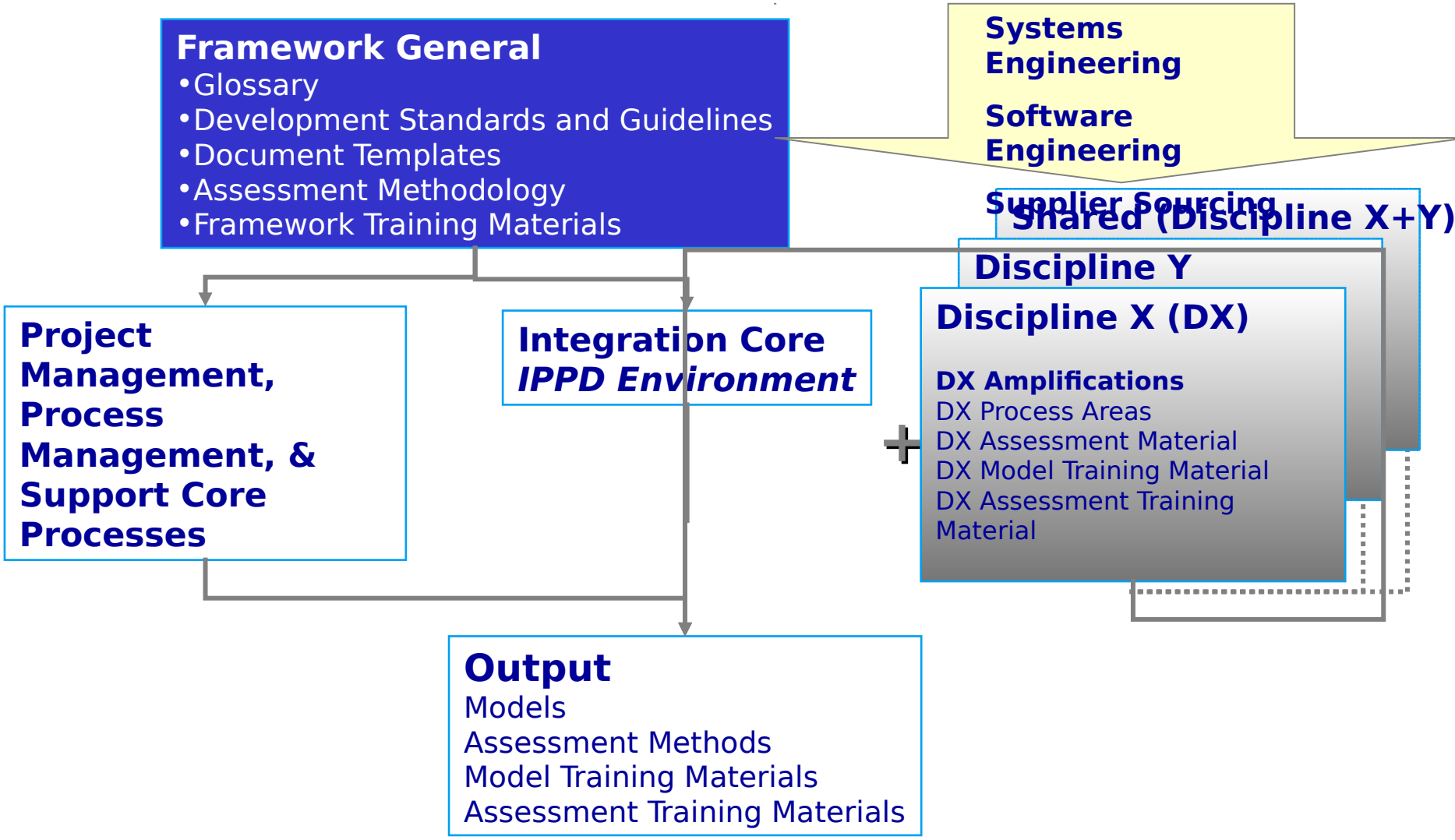
CMMI Design Goals

- Integrate the source models, eliminate inconsistencies, reduce duplication
- Create a Framework to add future disciplines without duplication of core process areas
- Reduce costs of implementing model-based process improvement
- Increase clarity and understanding
  - Common terminology
  - Consistent style
  - Uniform construction rules
  - Common components
- Assure consistency with ISO 15504
- Be sensitive to impact on legacy efforts

CMMI Source Models



The CMMI Framework



Comparing SW-CMM to CMMI

IPPD Changes

- CMMI-SE/SW/IPPD adds two new Process Areas
  - Organizational Environment for Integration (OEM)
    - SG 1 Provide IPPD Infrastructure
    - SG 2 Manage People for Integration
  - Integrated Teaming (IT)
    - SG 1 Establish Team Composition
    - SG 2 Govern Team Operation
    - SG 3 Institutionalize a Defined Process
- Revised Integrated Project Management (IPPD) PA
  - The last time this will be done (Complicates Model)
- Adds two Specific Goals to IPM
  - SG 3 Use Project's Shared Vision for IPPD
  - SG 4 Organize Integrated Teams for IPPD
- IPPD Amplifications and references
- New glossary definitions and acronyms
- Overview Material

Supplier Sourcing Changes

- **Intended for use on complex programs**
  - *When suppliers to perform critical functions or add modifications to products*
  - *When the project benefits from enhanced source analysis and from monitoring supplier activities before product delivery*
- **CMMI-SE/SW/IPPD/SS adds a new Process Area:**
  - Integrated Supplier Sourcing (ISM)
    - SG1 Analyze and Select Sources of Products
      - SP1.1-1 Analyze Potential Sources of Products
      - SP1.1-2 Evaluate and Determine Sources of Products
    - SG2 Coordinate Work with Suppliers
      - SP2.1-1 Monitor Selected Supplier Sources
      - SP2.2-1 Evaluate Selected Supplier Work Products
      - SP2.3-1 Revise the Supplier Agreement or Relationship
  - **Supplier Sourcing amplifications and references**
  - **New glossary definitions and acronyms**
  - **Overview material**

Model Comparisons – Duplication versus Integr

Release	PAs/ FAs	Goals/ Themes*	Activities/ Practices**
SW-CMM V1.1	18	52	316
SW-CMM V2C	19	62	318
EIA/IS 731	19	77	383
IPD-CMM V0.98	23	60	865
SA-CMM	17	44	114
CMMI V0.1 SE/SW	27	149	550
CMMI V0.2 SE/SW	24	80	528
CMMI V1.1 SE/SW	22	70	417
CMMI V1.1 SE/SW/IPPD	24	76	460
CMMI V1.1 SE/SW/IPPD/SS	25	78	465

38 61 78 23 9 199 243 70 1 1566 1780

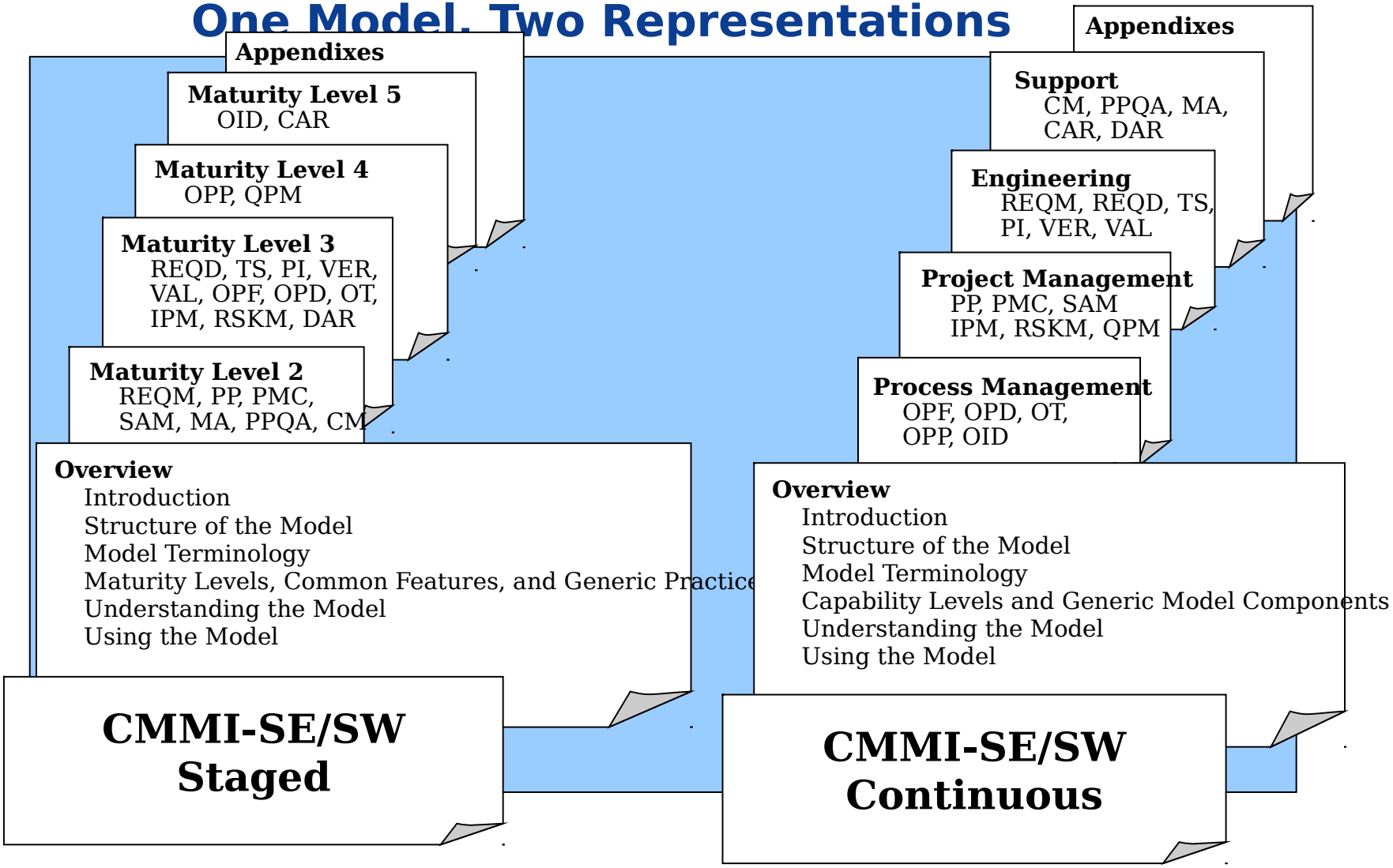
Legend:

* = Ratable components (Maturity Rating (e.g., Level n)

** = Key to implementation effort

CMMI Structure

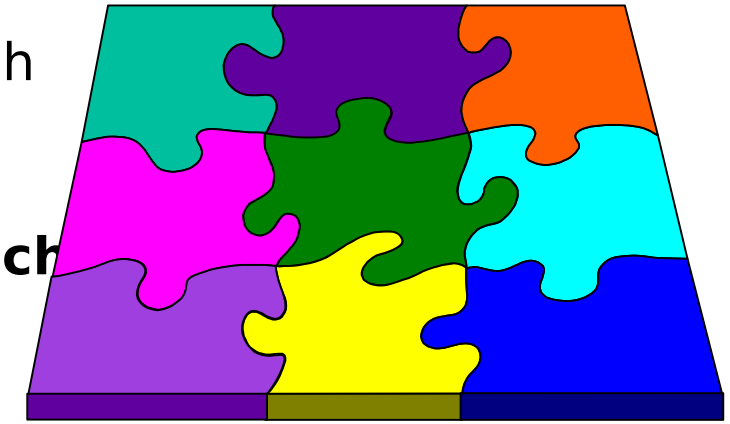
One Model, Two Representations



CMMI Model Representations

An organization may choose to approach process improvement from either the

- **process capability approach**
- **organizational maturity approach**



➢**CMMI models support each approach with *representation***

- **Process capability approach – continuous representation (process capability level rating by process)**
- **Organizational maturity approach – staged representation (Maturity Level rating, Level n)**

➢***"Equivalent staging is a target staging that is equivalent to the maturity levels of the staged representation."***

➢***Representations only get complicated during Appraisals!***

Equivalent Staging (Appendix F)

- Achieving a Maturity Rating using the Continuous Representation

A general rule for equivalent staging:

- To achieve maturity level 2, all process areas assigned to maturity level 2 must achieve capability level 2 or above.
- To achieve maturity level 3, all process areas assigned to maturity levels 2 and 3 must achieve capability level 3 or above.
- To achieve maturity level 4, all process areas assigned to maturity levels 2, 3, and 4 must achieve capability level 3 or above.
- To achieve maturity level 5, all process areas must achieve capability level 3 or above.

Equivalent Staging Diagram
(Appendix F)

- The achievement of capability level 4 for process areas cannot be predetermined
  - The choices about which processes are quantitatively managed depend upon the needs of the organization
- Target profile 4 does not extend to every PA
  - Although some process areas will have achieved capability level 4.
- Treatment of target profile 5 is similar.

Name	Abbr	ML	CL1	CL2	CL3	CL4	CL5
Requirements Management	REQM	2		Target Profile 2			
Measurement and Analysis	MA	2					
Project Monitoring and Control	PMC	2					
Project Planning	PP	2					
Process and Product Quality Assurance	PPQA	2					
Supplier Agreement Management	SAM	2					
Configuration Management	CM	2					
Decision Analysis and Resolution	DAR	3			Target Profile 3		
Product Integration	PI	3					
Requirements Development	RD	3					
Technical Solution	TS	3					
Validation	VAL	3					
Verification	VER	3					
Organizational Process Definition	OPD	3					
Organizational Process Focus	OPF	3					
Integrated Project Management (IPPD)	IPM	3					
Risk Management	RSKM	3					
Integrated Supplier Management	ISM	3					
Organizational Training	OT	3					
Integrated Teaming	IT	3					
Organizational Environment for Integration	OEI	3					
Organizational Process Performance	OPP	4			Target Profile 4		
Quantitative Project Management	QPM	4					
Organizational Innovation and Deployment	OID	5			Target Profile 5		
Causal Analysis and Resolution	CAR	5					

CMMI Today

- Stable Version 1.1 CMMI Product Suite was released January 2002.
- CMMI models will not change until 2005 at earliest.
- Many defense, aerospace, and commercial organizations are upgrading to CMMI.
- One appraisal method, SCAMPI, covers
  - internal process improvement
  - supplier source selection
  - contract process monitoring

Standard CMMI® Appraisal Method for Process Improvement (SCAMPI℠)

- **SCAMPI Method Definition Document (MDD) v1.1**
  - Became dual purpose
    - Internal Assessments for Process Improvement
    - External Evaluations for Source Selection or Contract Monitoring
  - Became a Method Definition Document (SCAMPI) instead of Method Description Document (CBA IPI)
    - More firm sense of direction
- **SCAMPI v1.1 intended to reduce appraisal time**
  - Favors verifying reasonable objective evidence
  - Pre-appraisal collection by organization reduces time on site
- **Introduces Practice Implementation Indicators to gather and retain information for reuse**

SCAMPI Recommended Appraisal Technique

TRADITIONAL

discovery-based appraisal

- **Limited objective evidence is provided prior to the appraisal**
- **Appraisal team must probe and uncover to obtain sufficient coverage of CMMI model practices.**
- **Discovery-based appraisals take longer**
  - Involved substantially greater appraisal team effort

RECOMMENDED

verification-based appraisal

- **Objective evidence is provided by the appraised organization.**
- **Focus is on verifying objective evidence**
  - **In advance of the appraisal,**
- **Reduces time on-site and overall appraisal time**

Practice Implementation Indicator (PII)

- To save time and create an organizational process baseline

- An objective attribute or characteristic used to verify the conduct of an activity or implementation of a CMMI model specific or generic practice.
  - PIIs include
    - direct artifacts
    - indirect artifacts
    - affirmations

    [derived from 15504-9 and MDD method overview]
- The actual conduct of an activity leaves footprints that provide a basis for verification.
- Retention of the PII footprints will aid an organization in preparing for subsequent appraisals

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CMMI SM

So!
– How is the transition going?

CMMI Transition Status – 6-30-03

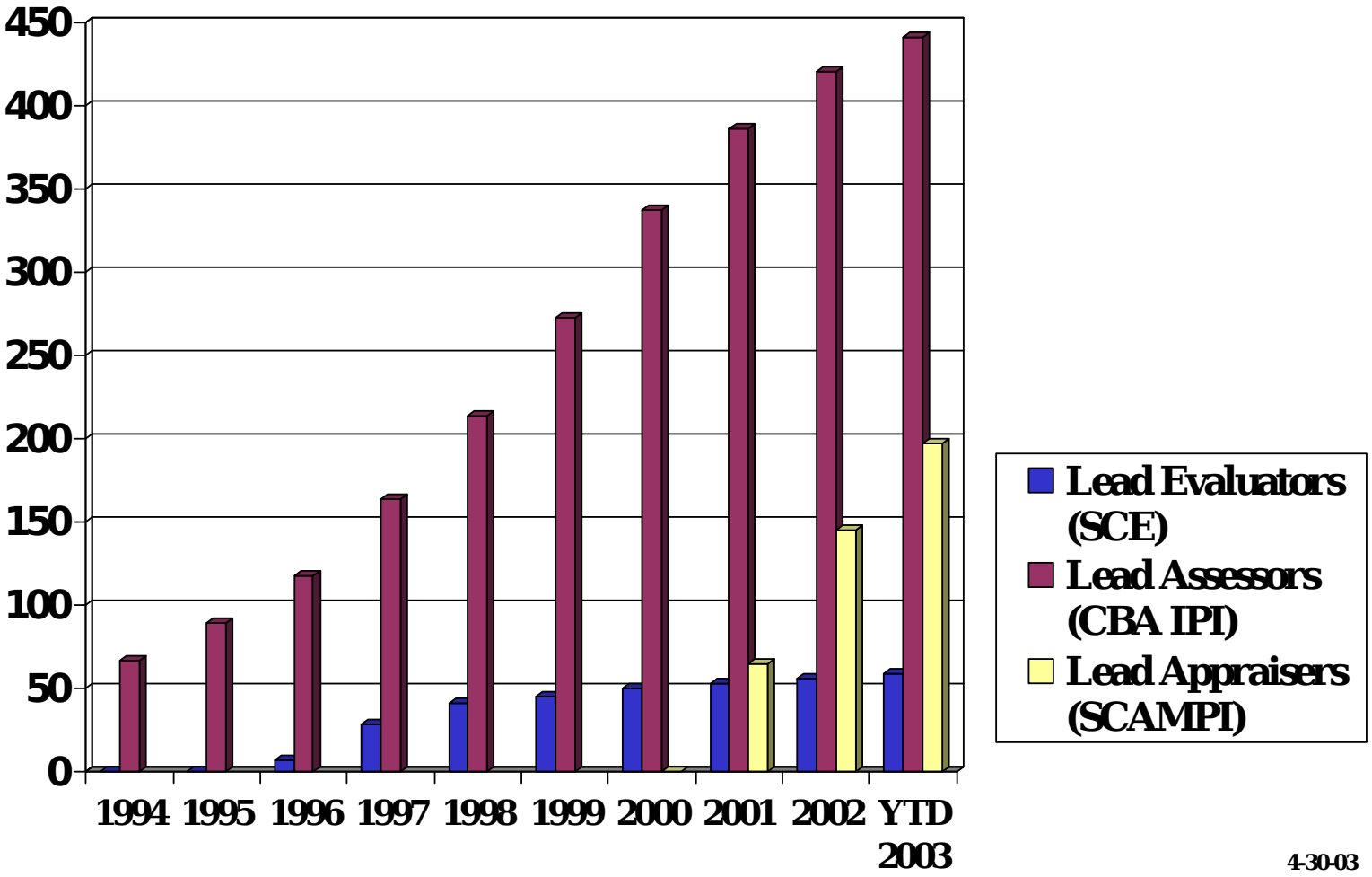
Training

Introduction to CMMI - **8683** trained
Intermediate CMMI - **592** trained
Introduction to CMMI Instructors - **182** trained
SCAMPI Lead Appraisers - **264** trained

Authorized

Introduction to CMMI V1.1 Instructors - **133**
SCAMPI V1.1 Lead Appraisers – **200**

Number of Lead Appraisers Authorized (Cumulative)



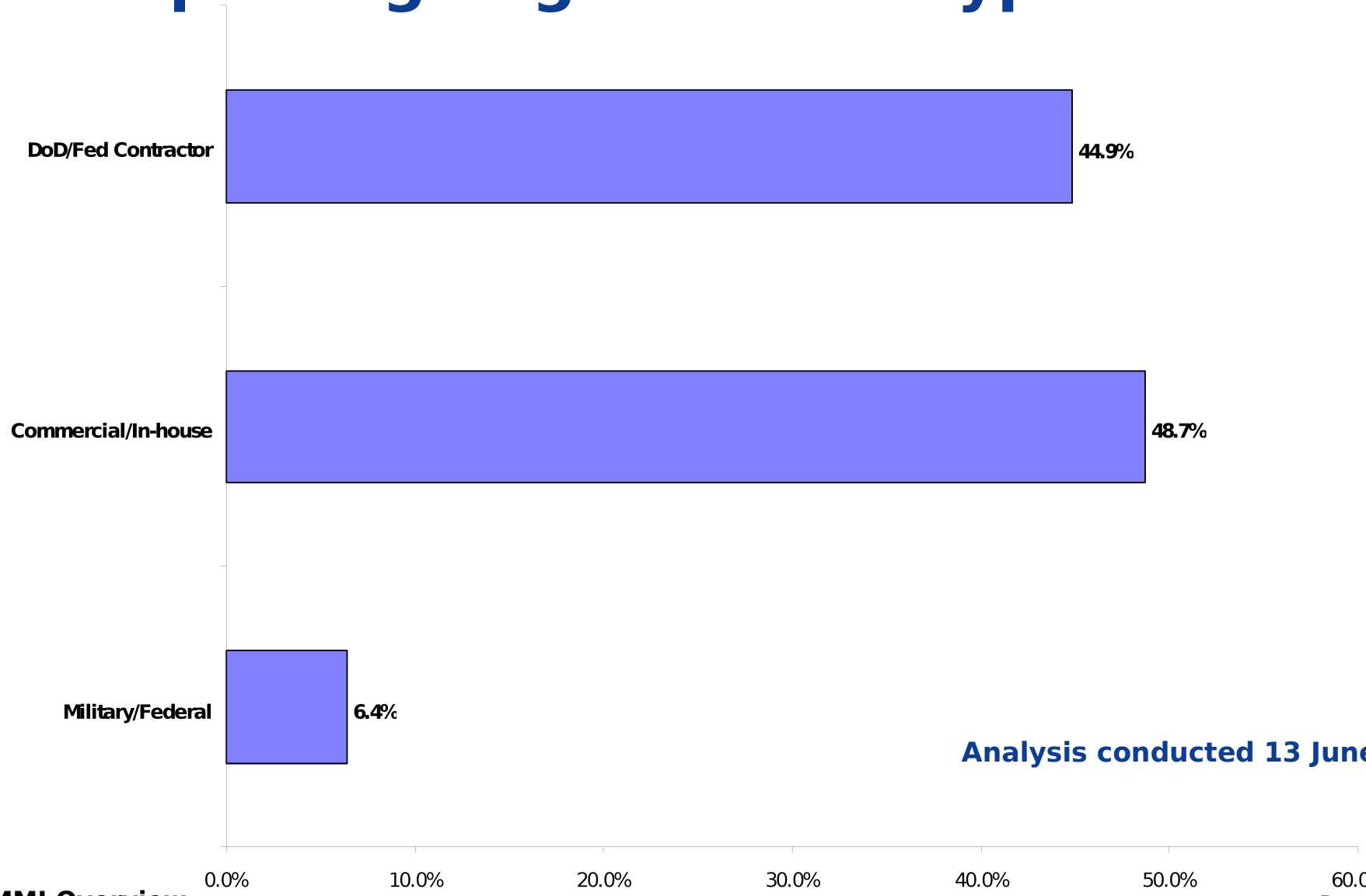
SCAMPI℠ Version 1.1 Appraisals*

- 87 Appraisals
- 81 Organizations
- 46 Participating companies
- 12 Countries
- 57% Non-U.S. organizations

Analysis conducted 13 June 2003

- ***Per data in PAIS database covering the period late May 2002 – early June 2003.**

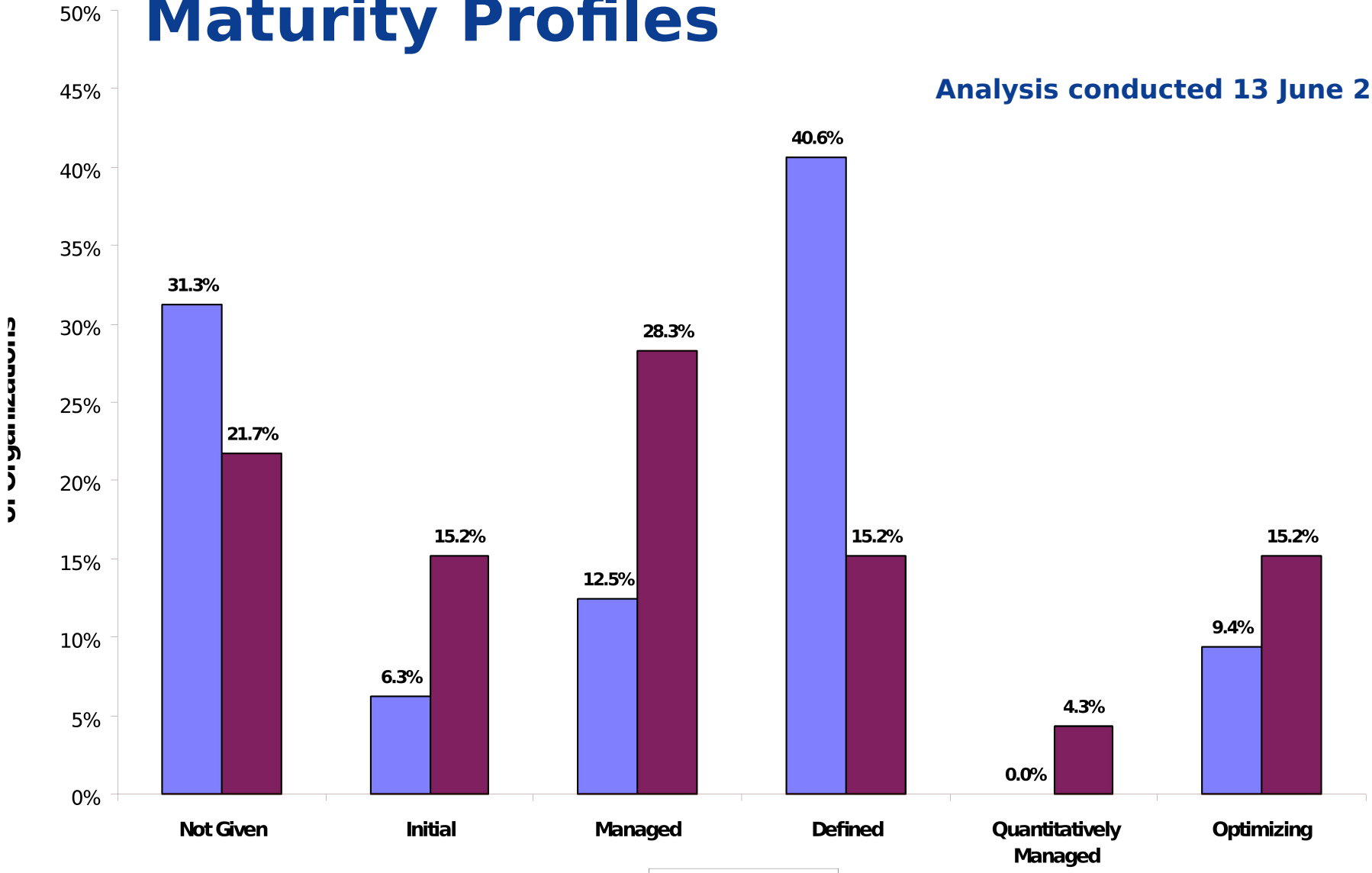
Reporting Organization Types

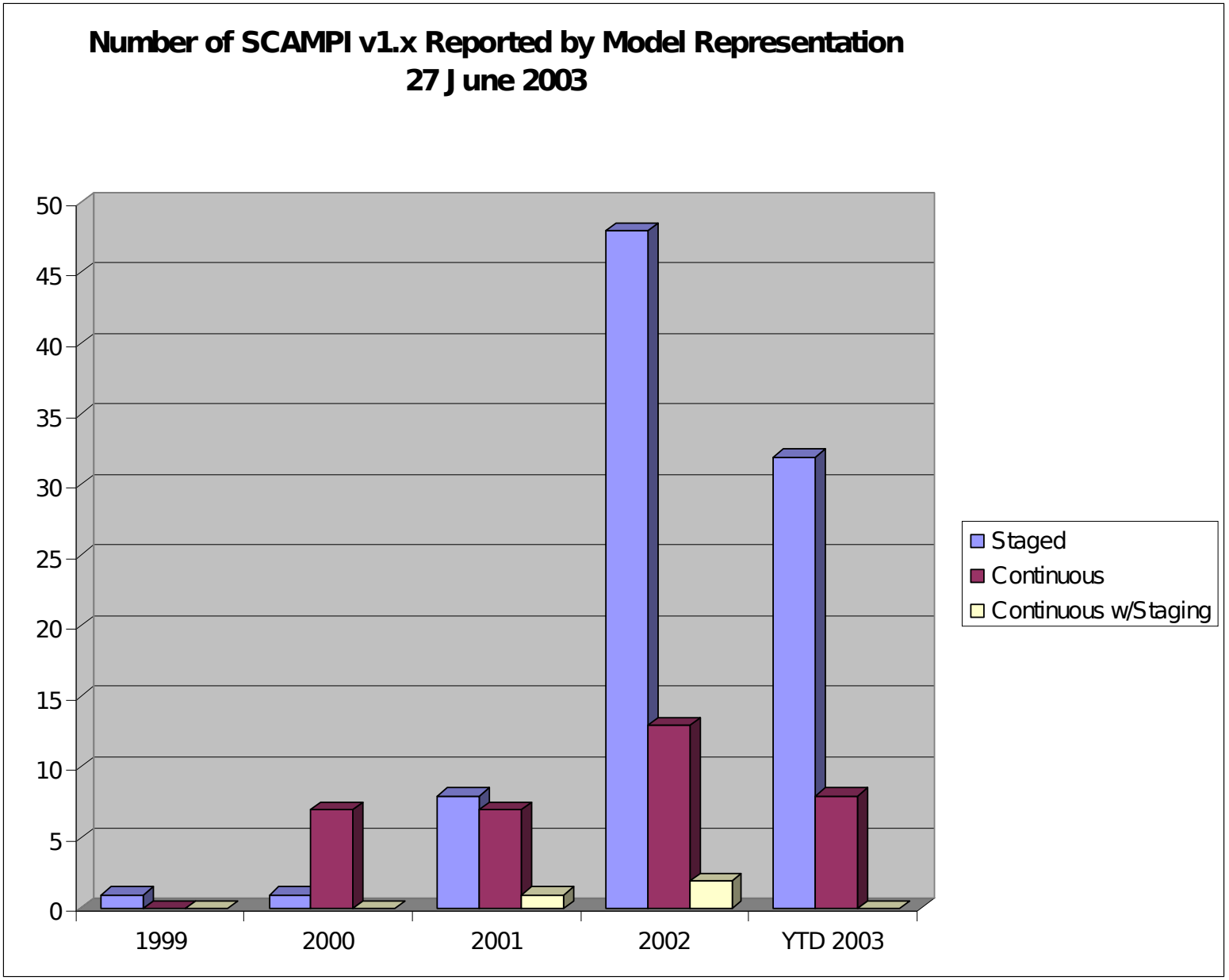


Analysis conducted 13 June 200

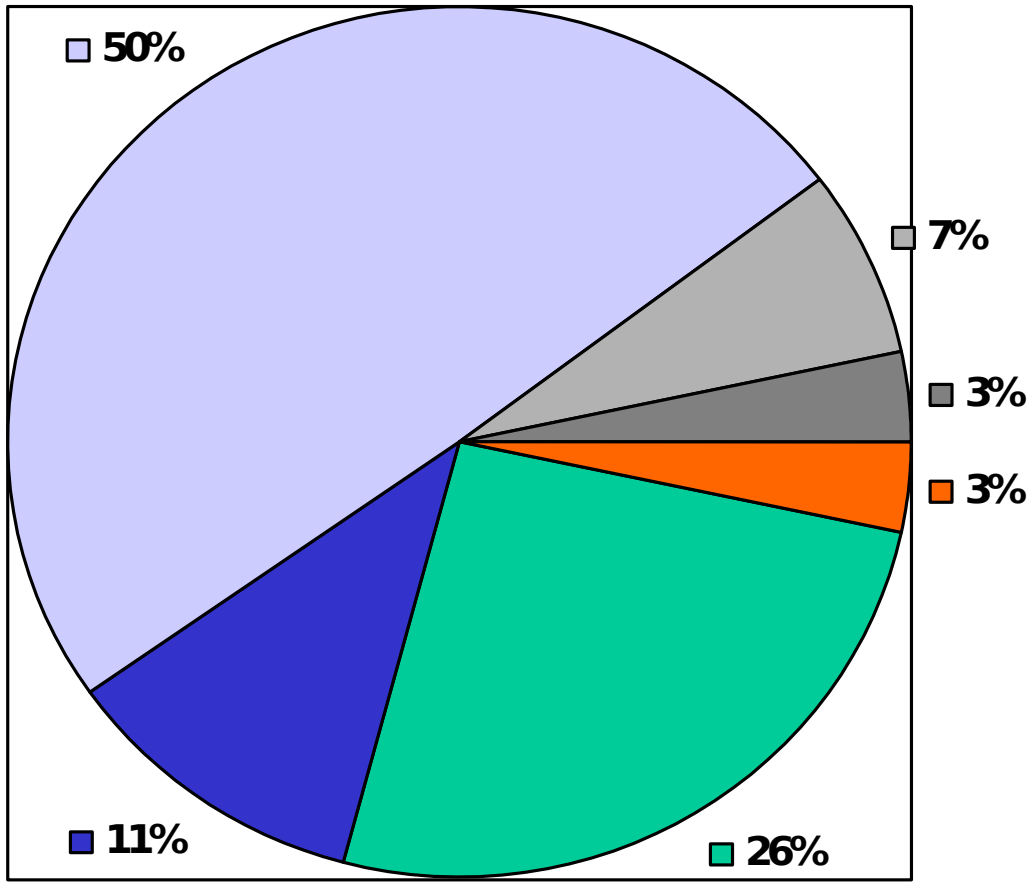
U.S. and Non-U.S. Organization Maturity Profiles

Analysis conducted 13 June 2003




Number of SCAMPI v1.x Reported by Model Representation
27 June 2003
50
45
40
35
30
25
20
15
10
5
0
1999
2000
2001
2002
YTD 2003
Staged
Continuous
Continuous w/Staging

CMMI Disciplines Used in Appraisals



For More Information

SEI CMMI Web Site

http://www.sei.cmu.edu/cmmi/

Backup Slides

Data Management in CMMI-SE/SW/IPPD/SS v1.1

- Project Planning (PP)
  - SP 2.3-1 Plan for Data Management
  - SP 2.7-1 Establish Project Plan
    - Sample includes Data Management Plan
  - GP 2.5 – Train People
    - Sample training topic is Data Management
  - GP 2.6 – Manage Configuration
    - Sample work product = Data Management Plan
  - GP 2.7 – Identify & Involve Stakeholders
    - Sample Activity = Review Data Management Plan
  - GP 2.9 – Objectively Evaluate Adherence
    - Example work products reviewed = Data Management Plan
- Project Monitoring & Control (PMC)
  - SP 1.4-1 Monitor Data Management
  - GP 2.5 Train People
    - Sample training topic is Data Management
  - GP 2.7 Identify & Involve Stakeholders
    - Sample Activity = Review Data Management Plan
- Configuration Management (CM)
  - GP 2.3 Provide Resources
    - Example = Data Management Tools

Quality Management Maturity Grid

Management Categories	Stage 1: Uncertainty	Stage 2: Awakening	Stage 3: Enlightenment	Stage 4: Wisdom	Stage 5: Certainty
Cost of quality as % of sales	Reported: unknown Actual: 20%	Reported: 5% Actual: 18%	Reported: 8% Actual: 12%	Reported: 6.5% Actual: 8%	Reported: 2.5% Actual: 2.5%
Summation of company quality posture	"We don't know why we have quality problems."	"Must we always have quality problems?"	"We are identifying and resolving our quality problems."	"We routinely prevent defects from occurring."	"We know why we don't have quality problems."

Crosby, P. *Quality is Free: The Art of Making Quality Certain*. New York: McGraw-Hill, 1979.

Summary of Significant Differences Between SW-CMM v1.1 and CMMI-SE/SW

- ***Measurement and Analysis*** **PA at Maturity Level 2**
  - **Based upon experiences of mature companies**
  - **Recognition that emphasis missing in SW-CMM made achievement of Level 4 QPM more difficult**
- ***Risk Management*** **PA at Maturity Level 3**
  - **Elevation of Risk Management to match the emphasis within DoD and Industry**
  - **Matches the Systems Engineering emphasis in SECM**
- ***Decision Analysis and Resolution*** **PA at Maturity Level 3**
  - **Matches the emphasis from the Systems Engineering models**
- **Expansion of *Software Product Engineering* kpa**
  - **Moves important SPs to the PA level**
  - **Finally gives the practices of Software Product Engineering an appropriate place in the CMMI**
- **Refocus from old *Measurement and Analysis* Common Feature (CF) to new *Directing Implementation* CF**

Advantages of Each Representation

Continuous Representation	Staged Representation
Provides maximum flexibility for order of process improvement	Predefined and proven path with case study and ROI data
High visibility of improvement within process areas	Focuses on organizational improvement
Easy upgrade from EIA 731	Easy upgrade from SW-CMM
Easy comparison to ISO 15504	Provides familiar benchmarking capability
Improvement of process areas can occur at different rates	Overall results summarized in a maturity level

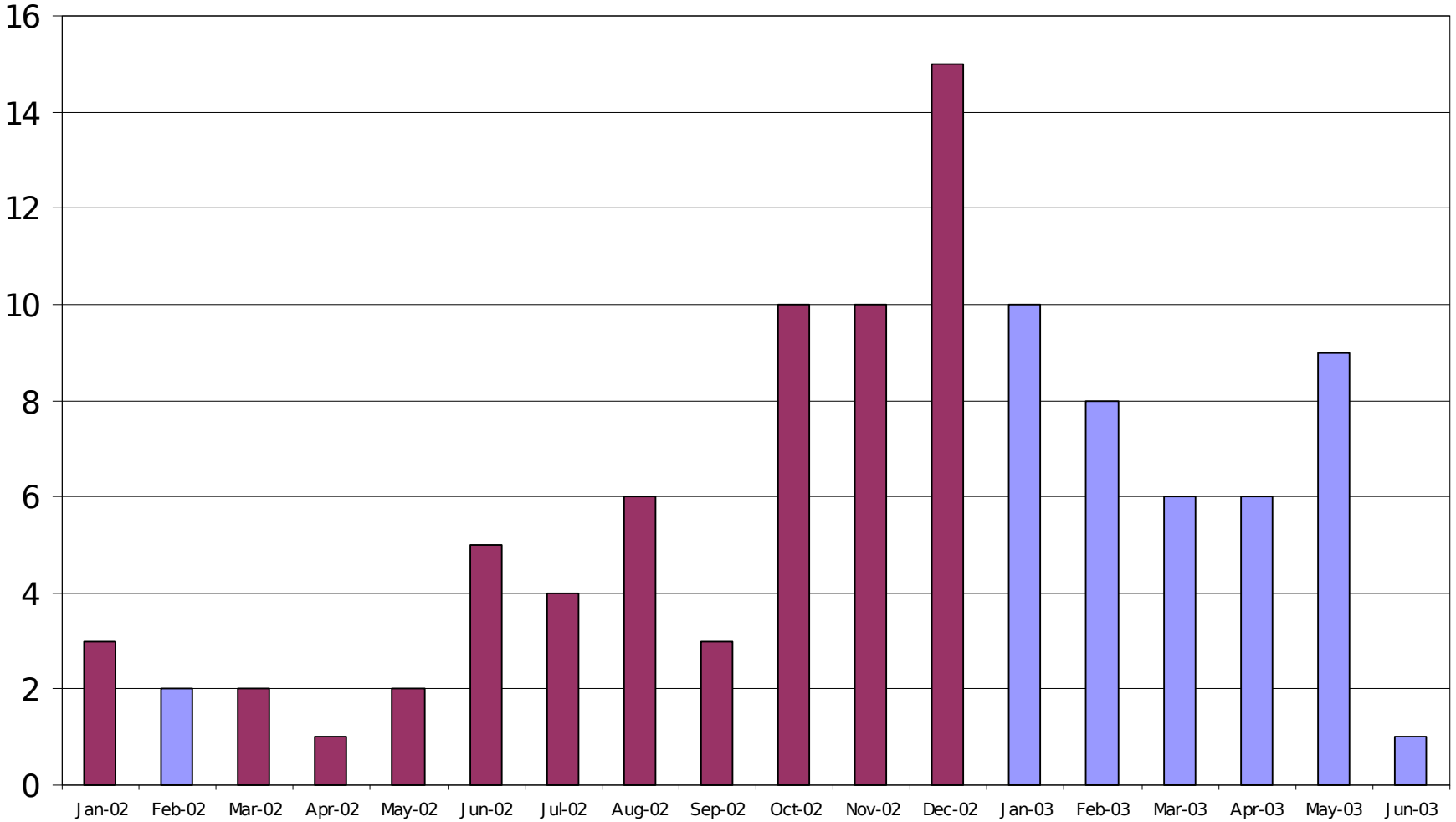
SCAMPI – Comparison

- Meeting the 100 hour goal for Level 3 appraisals (SE/SW)

- **CMMI V1.0 Pilots with SCAMPI v1.0**
  - **4 pilots**
  - **Team size – 6 to 12**
  - **3 included acquisition & IPPD**
  - **Median 128** ←
    - **Max 144**
    - **Min 90**
  - **Adjusted for SE/SW**
  - **Median 109** ←
    - **Max 130**
    - **Min 85**

- **CMMI v1.1 with SCAMPI v1.1**
  - **87 appraisals**
  - **Team size 5 – 8**
  - **Most SE/SW staged** ←
  - **Median < 100**

Number of SCAMPI v1.x Appraisals Reported by Month
27 June 2003



SCAMPI Lead Appraisers with Other Credentials